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MODERN QUARRY REFUSE AND THE PALÆOLITHIC THEORY.

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ONE of the most important industries engaged in by the American aborigines in pre-Columbian and largely also in post-Columbian times was the search for and acquirement of the raw material for making implements and utensils of stone. Quarying and mining were carried on in many placss upon a vast scale, and in one case at least the work has been prosecuted without interruption down to the present time. The operations were, in most cases, carried on in remote or out of the way places, so that the sites remained for a long time undiscovered, and the industry and its accompanying arts have to a great extent escaped the attention of archæologists. This work is now undergoing thorough investigation, and will henceforth take its place among the most important achievements of the native races, a work claiming precedence over nearly all others, lying as it does at the very threshold of art and constituting the foundations upon which the superstructure of human culture is built. Within the limits of the United States flint, chert, novaculite, quartz, quartzite, slate, argillite, jasper, pipestone, steatite, mica, and copper were most extensively sought.

The work in the quarries producing flakable varieties of stone was confined almost exclusively to obtaining and testing the raw material and to roughing out the tools and utensils to be made. The quarrying was accomplished mainly by the aid of stone, wood, and bone utensils, aided in some cases, perhaps, by fire. With these simple means the solid beds of rock were penetrated to depths often reaching twenty-five feet, and extensive areas were worked over, changing the appearance of valleys and remodeling hills and mountains. The extent of this work is in several cases so vast as to fill the beholder with astonishment. In one place in Arkansas it is estimated that upwards of 100,000 cubic yards of stone have been removed and worked over. The most notable features of these remarkable quarry sites are the innumerable pits and trenches and the heaps and ridges of excavated *dêbris* and refuse of manufacture surrounding them.

Many of the excavations have a new look, as if deserted but recently, whilst others are almost wholly obliterated as if by age. It is essential to observe, however, that where pits are sunk in solid rock and upon convex surfaces they fill very slowly, and that those in friable materials and upon slopes or concave surfaces fill rapidly. The oldest appearing may, therefore, be the youngest.

Several great quarries from which the flaked stone implements of the aborigines were derived have been examined. One of the most important is situated in the District of Columbia, two are in Ohio, two occur in Arkansas, one is in Pennsylvania, and another in the Indian Territory. These quarries cover areas varying from a few acres to several square miles in extent. They are pitted and trenched to various depths, and are thickly strewn with the *dêbris* of manufacture, including countless numbers of partially worked or incipient implements rejected on account of defects of texture and fracture resulting in eccentricities of shape. These rejects are extremely uniform in type in these quarries as well as elsewhere throughout the country, varying little save with variations in the nature and conditions of the raw material, the general result aimed at being always the same. It is therefore inadvisable in this brief sketch to describe the quarries separately or in great detail, as other more important matters must receive attention.

Rudely flaked stones are not confined to the great quarries; the raw material was worked wherever it was found scattered over the surface of the ground. The refuse deposits of village and lodge sites located conveniently to the stone-yielding districts also naturally contain many rejects of manufacture. Beyond these limits — the limits of the raw material — the rude specimens are rarely found. The main difference between the quarry shaping and the shaping done upon isolated shops and village and lodge sites is that upon the former, where the work was carried on extensively and consisted in securing the raw material in convenient form for transportation and trade, no specialization was undertaken, whereas upon ordinary shop and dwelling sites the full range of the roughing-out and finishing operations was sometimes conducted, the implement shaped being carried directly through from beginning to finish. In all cases the operations of shaping were, in the quarries, confined to free-hand percussion, further and more refined shaping being conducted elsewhere and employing the more delicate methods of indirect percussion and pressure.

The hammers used in breaking up the rock and in flaking are very numerous in most of the quarries; 500 examples, varying from 1 to 12 inches in diameter, were picked up in a few days' work in one of the great quarries of Arkansas. These hammers are generally of artificially discoid or globular forms. Such artificial forms of hammers are rare, however, in the bowlder quarries of the east, since bowlders of suitable form could be picked up on all hands and were discarded and fresh ones selected before the outline was perceptibly or seriously modified by use.

The true quarry, or more properly speaking the quarry-shop, product — that is to say, the articles made and carried away — may readily be determined in each case. This is rendered easy by the occurrence in the quarries of specimens broken at all stages of progress from the beginning to the end of the roughing-out process. The final quarry-shop form — and it must be especially noted that there was practically but one form — is naturally something beyond or higher than the most finished form found entire among the refuse. This form is necessarily, however, quite well represented by specimens broken at or near the final stages of the work. A most exhaustive examination of the great quarry sites has shown beyond the shadow of a doubt that this final form was almost exclusively a leaf-shaped blade, represented on the sites most accurately by broken pieces, all the acceptable blades having been carried away. This is the blade, varying in size and outline with the nature of the material and the particular end kept in view by the workmen, so often found in caches or hoardes distributed over the country and occurring in greater or less numbers on nearly every important village site. The place of this blade in the series of progressive stages of the manufacture of flaked tools is readily ascertained by a systematic study of the subject. It is the form through which nearly every common American variety of highly-developed flaked tool must pass before its final specialization is attempted. It is the blank form ready for the finishing shops, tested in the quarry shops for quality of material and availability for further elaboration, and reduced in weight so far, and only so far, as to make transportation easy or profitable.

In most of the quarries a limited number of cores are found, from which small, generally very delicate, flakes were removed for use in the arts, and used, as a rule, apparently without much modification of shape. They were probably hafted for uses in which delicate manipulation was necessary. Their production was not an important feature of the quarry-shop work.

The question, very properly raised, as to what we really know of the nature and destination of the leading quarry-shop product, the blade or blank form, may be answered by asking another

question. Let us inquire whence came the millions of flaked implements of quartz, quartzite, chert, flint, slate, argillite, jasper, and novaculite that cover the hills and valleys of America, that occur upon every fishing-ground, shell bank, refuse heap, and village site occupied by the American aborigines, historic and prehistoric? They did not grow to be picked like ripe fruit from trees, nor could they have been dug up like potatoes from the ground. Where are the quarries and the shops from which the Indian secured his enormous supplies? For every million of spear and arrow points, knives, perforators, and scrapers — and there were many millions used by him — there are somewhere in America many times as many millions of broken and malformed failures of the very kind found in our quarries and shops, and where are they now but in these quarries and shops? The conclusion is inevitable. The finished and the unfinished (or rude) forms complement each other, and constitute a unit in art and in time. It was only our entire lack of knowledge of the subject that made other theories necessary or other conclusions possible.

These determinations with respect to the nature of the great body of the rudely-flaked stones of America may be expected to have some bearing upon the question of the occupation of this continent in glacial times by a people not yet advanced beyond the primal or palæolithic stage of culture, since the theory of that occupation is based upon the discovery of closely analogous objects in the gravels and elsewhere.

Before the refuse of quarrying and manufacture were studied and the true nature of the rudely-flaked forms determined, these objects had been quite extensively collected, and because of their rudeness and their supposed close resemblance to the early forms of European flaked-stone tools, had been classed as palæolithic and were so labelled in many museums, and as such found a place in the archæologic literature of both continents. It is now conceded by scientific men that this is all wrong, and that in the present state of our knowledge the separation of a single specimen from the main body of flaked stone art in America, save upon purely geologic evidence, is wholly unwarranted.

It is manifestly folly to attempt to select from the mass of these objects certain individual specimens to be arbitrarily called palæolithic. The selections made are quite as likely to be the youngest as the oldest. It is a well-established fact that many of the rudest flaked forms known, the simplest possible art shapes, are obtained from the shell-deposits and from the soapstone quarries of the eastern United States, and thus represent the most modern phases of neolithic Indian work in stone. Even if it be conceded for the sake of argument that there are multitudes of true palæolithic objects and implements scattered over the country, it is certain that up to the present date we have established no standards of form-comparison by means of which they can be detected.

Until geologic formations, glacial or otherwise, have furnished demonstrably palæolithic forms in sufficient numbers to warrant the establishment of types of implements peculiar to these formations, surface finds can be of no service whatever to advocates of the palæolithic idea.

The reported discovery of rude forms of implements in the gravels at Trenton, New Jersey, and subsequently at several points in the Mississippi Valley, led to the conclusion that palæolithic man dwelt here in gravel-forming time, and the theory that a well-differentiated period of rude flaked stone art precedes, in the normal order of development, a pecked and polished stone period, found a foothold in this country. Observations have multiplied, and the occurrence of flaked stones in the gravels is now supported by a large body of evidence. If even a small percentage of these observations are authentic, the evidence ought to be considered sufficient to settle *one* of the questions at issue, that of the *age* of occupation; for the finding of a very small number of works of art, either implements, shop rejects, or flakes — in fact, anything artificial — in the gravels by competent and reputable observers of geologic phenomena is all that is required to satisfy the scientific world of the presence of man of some grade of culture, primitive or otherwise, in gravel-forming times. To this conclusion there can be no serious objection. So far as I know, the possibility that there were glacial men, inter-glacial, and post-glacial men somewhere upon the continent is not seriously questioned by any one. The infancy of the race may have been passed upon the eastern continent, but there is no sufficient reason why America may not have had a share in the nursing.

As I am not prepared to challenge the testimony brought forward by various collectors tending to establish the glacial age of human occupation, defective as much of that testimony seems to be, I will not raise the question of age, but proceed to consider the bearing of the evidence furnished by the quarry shops upon the question of the *grade* of culture indicated by the so-called gravel finds; the *age*, or period, of the occupation and the grade of culture attained being two very distinct things. Admitting for present convenience, then, that men dwelt in America in glacial times, I take up the question as to whether the culture of the hypothetic people, as indicated by the evidence furnished, is surely palæolithic. It has been repeatedly stated, and is still believed by many, that the gravel finds of the eastern United States closely resemble well-established European types of palæolithic implements. The critical observer will find, however, that this resemblance is superficial, and that they have a very much closer analogy with the rude quarry-shop rejects of America; and the latter are not really implements, and should not be called such any more than the faulty blocks of marble left in and about the quarries at Carrara should be classed as statuary. The distinctive feature of European palæolithic implements is, or ought to be, their evidence of specialization of form, their adaptation to definite use, indicated by what is known as secondary flaking; whereas these objects from the American gravels, with rare exceptions indeed, exhibit a total lack of this character. The semblance of specialization in thousands of the rude quarry rejects which have been worked hardly more than to test the flakability of the stone, not having begun to assume the contour and appearance of the implement contemplated by the workman, is more pronounced than in any of these gravel specimens. Appearance of specialization of form, may, therefore, signify nothing, and, if found, must not be taken alone as sufficient evidence that the object having it is a *bona fide* implement.

It should be further noted that not only are the gravel finds identical in form and material with the ordinary failures of the modern aborigines, but that they display the same mastery of shaping operations, beginning in the same way, progressing along the same lines, and ending at the same points, exhibiting no evidence of special adaptation to use in cutting, digging, picking, striking, or any other primitive manipulative act. It is also observed that none of these articles exhibit well-defined evidences of having been used, although it must be conceded that the rudest peoples made their tools for use; and it would appear that, as a rule, if they had been used they would bear very decided indications of that use, and would show a certain amount of specialization as a result of that use. Considering all of these points, I call attention to the extreme probability that these reputed gravel objects are not implements at all, but ordinary failures resulting from the manufacture of more highly specialized forms.

Again, it will be remembered that the gravel finds of the Pacific coast and some of those east of the mountains are neolithic, the forms being of a high grade technically and functionally, so that neolithic man is shown to have probably existed upon the continent whilst the eastern gravels were forming, and the condition of the art phenomena imply that he had dwelt here or somewhere east, west, north, or south, for a very long time, for thousands of years, if not for tens of thousands, and that, too, since he had passed the primal stages of art designated palæolithic.

How then is it to be proved that these particular rude forms, found so sparingly scattered through the gravels at Trenton and elsewhere, really represent and prove a palæolithic age, since they may simply be the rejects of manufacture left upon the banks of the glacial rivers by advanced neolithic men, who dwelt as intelligent men would upon the upper terraces out of reach of the icy floods? The argument that in these gravels rude forms only are found has no value whatsoever, since, as I have shown, it is the rule that where the raw material was sought beyond habitable sites no work save the roughing-out was undertaken, and no flaked forms save rude ones were left upon the ground. Because a few dozen specimens of rudely-flaked stones are found in the

gravels, and no highly specialized forms or other works of art are found with them, the conclusion is reached that they are palæolithic implements and that the art of the gravel-forming time was exclusively rude or palæolithic. Yet we may go down to the Potomac in the District of Columbia, or to the Washita in Arkansas, or to the Neosho in Indian Territory, and gather tons of similar rude forms made by our modern neolithic tribes, without finding a single specialized form or a single object of art aside from these rude forms. It is not my intention, however, to try to reconstruct the culture of that time, as I am not sure that there was any culture, but to point out the total inadequacy of the evidence upon which the theories of a particular culture are based.

The torrent-swept flood-plains of glacial times were hardly habitable places, and we do not know that there was game or fish to be sought there; but the great beds of bowlders then and there accumulating furnished more or less raw material suitable for flaking, and if men, supposing they existed, coming down to the banks of the streams during periods of low water, essayed to rough-out their spear-points and knives in the usual fashion, the ever-recurring torrents would scatter the refuse about, leaving the coarse pieces in one eddy and whirling the lighter ones to other eddies below.

From this and from what has gone before it is clearly seen that these reputed gravel objects are probably not implements at all, and, whether they are or not, that they are as likely to have been left by neolithic as by palæolithic men.

So far have the advocates of a European classification for American phenomena gone beyond the limits of prudence in the treatment of these so called palæolithic stones, that a radical change is demanded in the methods of classifying and labelling these objects in many of our museums; and it is to be lamented that a revision of all literature relating to the subject cannot be made in order to prevent the further spread of errors already too deeply rooted in the minds of the people, without offensive criticism of the work of living students.

This point may be illustrated by one example of the many that could be cited. The quartz objects from Minnesota, usually known as the Babbitt finds, of which so much has been said and written, prove on careful examination to be modern work-shop refuse settled into the talus of the glacial terrace. The slightly worked pieces heretofore collected and published as palæolithic implements almost without question on the part of archæologists as to their origin or manner of occurrence, have no more intimate relation to the history of the glacial terraces than have the trees that grow upon their surface or the rodents that burrow in their sandy soil.

No rude flaked stone should be classified or labelled as an implement until it is proved to be an implement, and no specimen should be called palæolithic simply because it is rude or because it is found in the gravels, howsoever old. The attempt to classify these rude stones and to arrange them under types after the manner of European implements is sufficiently characterized, when it is stated that there is not in the museums of Europe or America a single piece of flaked stone found in place in the gravels of America and satisfactorily verified that can with absolute safety be classified as an implement at all.

If I should find a rude stone in place in the gravels — I have tried long in vain — I should permit myself to say only this, "Here is a work of art dating back to glacial times, I cannot tell whether it is a finished implement or not, as there are but slight signs of specialization and no indications of use, and I cannot tell whether it was made and left by a palæolithic or by a neolithic people, because neither of these peoples had a patent upon rude forms." Even if rude flaked stones are found in gravels ten times as old as the Trenton gravels, it must still be shown that they are not neolithic before it can be safely asserted that they are palæolithic, for the exclusively rude period of flaked art observed in Europe is so extraordinary that its repetition in other countries would approach the marvellous.

Little by little the advocates of a period of palæolithic culture in America have been forced to give up the idea that there is any other reliable test of the age of a culture than that furnished by geology; yet they are still going on utterly failing to recognize the equally important fact that geologic phenomena cannot be safely observed save by geologists, and I may add with respect to gravel phenomena that the observations of geologists are not always infallible, the observations of geologists who have not especially studied gravels being of little greater weight than those of laymen. They must further concede that the finding of rude implements in the gravels or other ancient formations is not proof of a palæolithic age until it is sufficiently proved that the culture represented is exclusively rude culture, a point not attained, and I fear well nigh unattainable.

It follows from the above considerations that all speculations upon the culture status, ethnic relationships and geographic distribution of gravel-man in America based upon the discovery of rude forms of art are premature and misleading, and that, instead of being on firm ground and well advanced in respect to the antiquity and history of early man in America, we are not yet safely on the threshold of the study; and it is patent that until geologists take hold of the problem and prosecute the work, not as a side issue but as a great and leading question germane to the field of geologic research, little true progress will be made.

My explorations have been made with the greatest care and rarely without the aid and advice of some of the foremost geologists and anthropologists of the country. The conclusions reached have been freely discussed, and are generally approved by those familiar with the facts. These conclusions are subject to modification through the acquisition of new evidence derived from actual research in the field and in no other way.

In closing I would add that conservative students of American archæology will find it wise to consider well the following points relating to early man in America. 1. Is there a sufficiently full and sound body of evidence to demonstrate the presence of glacial man in America? 2. Is there satisfactory evidence that glacial man, if his existence be admitted upon the evidence available, was in any particular region in the palæolithic stage of culture? 3. Is there satisfactory evidence that the rude glacial finds in any case are implements at all? 4. Are deductions as to the habits, customs, arts, industries, institutions, and racial affinities of a people called for until at least one implement left by them is discovered, verified, and found to bear indisputable evidence of adaptation to or employment in some kind of use?

MODERN SYNTHETIC GEOMETRY VERSUS EUCLID.

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FOR more than two thousand years Euclid has held almost undisputed sway in the field of synthetic geometry. So strong a hold has it on school men that few American colleges dare offer anything else to freshmen. Is this because of tradition, or is there something in Euclid that makes it intrinsically better than anything mathematics has produced in modern times? To say that it holds its place merely because of tradition would probably be too severe a criticism, and would certainly call forth vigorous protest from its friends and defenders. To say that the wonderful advance in geometrical science in the last two hundred years has given us nothing superior to Euclid would be a doubtful statement, and almost an insult to the labors of such men as Monge, Poncelet, Carnot, Steiner, Von Staudt, and Cremona. No other branch of mathematics clings so tenaciously to that which is old, as geometry. In analysis, physics, mechanics, astronomy, everywhere but in geometry, the results and methods of modern thought are freely used, and no one doubts the propriety of their use. Why not take advantage of the same advances in geometry?

I have no quarrel with Euclid. It has been and is still a great factor in education. The severe training it gives in logical, clear thinking would be hard to equal. No doubt every student leaves Euclid with his mental powers greatly strengthened, and with increased ability to grapple with other studies and with the practical problems of life. Considered as to its educational value, but few objections can be urged against it. Mathematically considered, there are many things in favor of the modern synthetic geometry. Euclid is far more nearly a treatise on logic than on